J. Soils and Crops 35 (2) 399-404, December 2025 ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

EVALUATION OF PHYSICO-CHEMICAL CHANGES IN PADDY SOILS AFFECTED BY ACQUACULTURE IN GODAVARI DELTA

T. Usha Rani[1], P. Munirathnam[2], O. Siva Devika[3] and P. Ammaji[4]

ABSTRACT

Aquaculture often contributes to soil salinization through seepage and percolation from ponds, impacting nearby agricultural productivity. This salinization also poses risks to local drinking water sources, highlighting key environmental concerns. The survey was carried out over a period of three consecutive years (2019–2021) to estimate soil characteristics in paddy fields adjacent to prawn and fish ponds. Soil samples were collected from areas adjacent to prawn and fish ponds in ten villages. For prawn pond-associated sites, samples were obtained from five villages: Bhatlamogaturu, Sriramapuram, Vissakoderu, Kopparru, and Saripalle. Similarly, samples associated with fish ponds were collected from five villages: Kodamanchili, Navuduru, Gondi, Chinamamidipalli, and Mallavaram. From each village, three soil samples were taken at a depth ranging between 10 and 30 cm. The sampling points were located at distances ranging from 5 to 70 meters from the adjacent aquaculture pond. All soil samples were analyzed for key physicochemical properties, including pH, electrical conductivity (EC), organic carbon content, available nitrogen (N), available phosphorus (P), available potassium (K), sodium (Na), sulphur (S) and total dissolved solids (TDS). In soils adjacent to prawn ponds, the mean values over a three-year period for selected soil parameters were as follows: pH ranged from 6.0 to 8.0, electrical conductivity (EC) from 3.2 to 4.2 dS m^{-1}, organic carbon (OC) from 0.35% to 0.42%, available nitrogen (N) from 135 to 165 kg ha^{-1}, available phosphorus (P_2O_5) from 18.6 to 34.8 kg ha^{-1}, available potassium (K_2O) from 309 to 435 kg ha^{-1}, sodium (Na) from 127 to 180 ppm, sulphur (S) from 7 to 14 ppm, and total dissolved solids (TDS) from 0.98 to 1.6 ppm. An increase in the levels of soil pH, EC, OC, and available N, P, and K with increasing distance from prawn ponds (without a trench) to paddy field was noticed. Conversely, concentrations of Na, S, and TDS showed a decreasing trend with increasing distance from prawn ponds lacking trench separation. Not much differences in soil physico-chemical properties were observed between soils adjacent to prawn ponds with trenching and those near fish ponds, irrespective of the presence or absence of trench systems. A buffer zone of 10/ m width and 4/ m depth with fresh water between aquaculture ponds and paddy fields can prevent soil salinization and support the coexistence of both practices, especially in clay soils. Sustainable aqua farming, along with integrated rice cultivation and organic soil amendments, can enhance productivity and soil health in coastal Andhra Pradesh.

(Key words : Aqua ponds, salinization, soil texture, buffer zone, seepage, sodicity, acidification, agriculture)

INTRODUCTION

In coastal regions, aquaculture has emerged as the most rapidly expanding food production sector. In the past decades aquaculture around the world has been pursued only on the basis of economic costs without considering the social costs and negative impacts on the environment. Aquaculture has diversified and intensified contributing significantly to economic and social wellbeing in many countries. Of this, a large scale of production comes from the small-scale production in developing countries like India. Andhra Pradesh ranks first in total fish and shrimp production and contributes more than 70% of cultured shrimp produced in India according to socio economic survey 2019-2020 conducted by planning department , Government of Andhra Pradesh. Rapid growth of shrimp and prawn farming in India lead to short and long term negative environmental impacts which were causing increased soil salinity, land degradation and sedimentation. Salinisation of soil in adjacent agricultural lands is a major environmental concern in regions practicing aquaculture. (Jayanthi *et al*., 2004). Shrimp farming releases large volumes

1. Professor and Head, Dept. of Soil Science and Agricultural Chemistry, Agricultural college, Rajamahendravaram – 533105, ANGRAU, Andhra Pradesh, India (Corresponding Author)
2. Technical Secretary to VC, LAM, Guntur – 522034, ANGRAU, Andhra Pradesh, India
3. Teaching Associate, Dept. of Soil Science and Agricultural Chemistry, Agricultural college, Rajamahendravaram – 533105, ANGRAU, Andhra Pradesh, India
4. Professor, Dept. of Agronomy, Agricultural college, Rajamahendravaram – 533105, ANGRAU, Andhra Pradesh, India

of organic and inorganic effluents, along with toxic chemicals, into the ecosystem, leading to increased soil toxicity (Flaherty *et al*., 1999).

The Godavari Delta, one of the most fertile and agriculturally productive regions in India, is traditionally known for its extensive paddy cultivation. This deltaic region, shaped by the mighty Godavari River, provides rich alluvial soils, abundant water resources, and a favorable climate for rice farming. However, in recent decades, the rapid expansion of aquaculture—particularly shrimp and fish farming has significantly altered land use patterns in the area. Farmers, enticed by higher economic returns, are increasingly converting agricultural lands into aquaculture ponds. Implementation of successful aquaculture strategies has the potential to significantly enhance the economic status of farmers (Butle *et al*., 2022 and Bodhe *et al.,* 2022). Rice farms are favoured sites for conversion into acqua ponds because they pose several characteristics well suited for acquaculture (Siddique *et al*., 2012). But marine aquaculture has been heavily criticized for its environmental impacts including pollution from fish waste and uneaten food escapes, chemicals to control diseases and parasites, and ecological impacts of sourcing raw materials from the sea to produce fish (Teng, 2008). The east coast of India offers excellent opportunity for irrigated agriculture due to availability of vast stretches of arable fertile land created by river and coastal deltas (Gupta *et al*., 2002).

Aquaculture practices often involve the use of saline or brackish water, chemical additives such as lime, antibiotics, and feed supplements, all of which can drastically affect the physical and chemical integrity of soils. The coastal regions suffer from environmental degradation due to increased salinity of soils, canals and ponds (Rahman *et al*., 2013 and Penmesta, 2013). Seepage of salt water into the adjacent agricultural lands from aquaculture ponds is well documented and sometimes it makes cultivation impossible. Seepage can result from saltwater intrusion, pond overflow, or the leaching of waste materials during rainfall events. The infiltration of saline water into adjacent paddy fields or the reconversion of aquaculture ponds back to agricultural use without adequate remediation can lead to detrimental changes in soil texture, soil structure, salinity, soil pH, soil nutrient availability, and soil organic matter content. These changes not only impact the soil's productivity but also threaten food security and the socio-economic well-being of farming communities in the delta. Typically, paddy fields are situated behind clusters of intensive aquaculture ponds. Local communities have often reported reduced rice yields and groundwater contamination, with salinization making vast stretches of land unfit for paddy cultivation. The salinity and sodocity of soil were found to be inversely proportional to the distance from the sea and aquaculture ponds (Rajarshi and Santra, 2011).

This research aimed to evaluate the physico-chemical changes in paddy soils that have been subjected to aquaculture in the Godavari Delta. The outcomes of this research are expected to provide valuable insights into the interactions between aquaculture practices and soil quality in the deltaic ecosystems. Such findings will be crucial for developing remediation strategies, guiding land-use planning, and ensuring the long-term sustainability of agriculture in the region.

MATERIALS AND METHODS

The aqua ponds were selected and soil samples were collected from farmer's fields from five villages Bhatlamogaturu, Sriramapuram, Vissakoderu, Kopparru and Saripalle cultivating shrimp/prawn without trench and Kodamanchili, Navuduru, Gondi, Chinamamidipalli and Mallavaram villages ponds cultivating fish without trench. Soil samples were collected over a period of three consecutive years (2019–2021), with three samples obtained from each village year^{-1}. Sampling was conducted at a depth of 10–30 cm at fixed distances of 0, 5, 10, 20, 30, 40, 50, 60, and 70 meters from the adjacent aquaculture pond toward the paddy field. The soil samples were analysed to determine pH, electrical conductivity, organic carbon and available NPK, Sodium percentage and TDS. The average values of the soil physico-chemical parameters, based on data collected over the three-year survey period, are presented. The soil samples from the paddy fields of farmers cultivating shrimp with trench were collected from Kuppanapudi, Penumanchili, Ganapavaram, Penumantra and Attili villages at a distance of 0, 5, 10, 20, 30, 40, 50, 60 and 70 m and the farmers cultivating fish with trench from the adjacent acquaponds are Likhithapudi, Vempa, Mogalthuru, Matsyapuri and Mamidigunta. The collected soil samples were analyzed for the chemical properties pH, EC, OC, available NPK, Sodium percentage and TDS by using standard procedures. Vertical changes in soil properties were examined at depths of 10, 20, and 30 cm in both trenched and non-trenched soils. The collected samples were analyzed following standard laboratory methods.

Sr. No.	Parameter	Method	Reference
1	pH	Soil and water 1: 2.5 ratio	Jackson, 1973
2	Electrical conductivity	Soil and water 1: 2.5 ratio	Jackson, 1973
4	Organic Carbon	Walkley and Black method, 1934	Jackson, 1973
3	Nitrogen	Alkaline permanganate method	Subbiah and Asija, 1956
4	Phosphorus	Olsens method	Olsen, 1954
5	Potassium	Neutral Normal ammonium acetate method	Muhr *et al*., 1965
6	Sodium	Neutral Normal ammonium acetate method	Muhr *et al*., 1965
7	Sulphur	Turbidity method	Bradsley and Lancaster, 1960
8	TDS	Filtration, evaporation and weighing	Jackson, 1973

RESULTS AND DISCUSSION

Acquaponds without trench in soils with prawn cultivation

Soil samples from five villages were collected and analyzed for various physico-chemical properties. The average values of these properties for each of the five villages are presented in Table 1. The average soil pH ranged in between 6 and 8, while the electrical conductivity was in between 3.2 to 4.2 dSm^{-1}. The pH and electrical conductivity decreased with increase in distance from the pond. Soil pH and electrical conductivity (EC) at a distance of 70 meters from the aquaculture pond showed a reduction of approximately 25% compared to values recorded at 5 meters from the pond. According to some studies, the pH and EC of soils in prawn and shrimp cultured ponds were found in alkaline range (Zafar *et al*., 2015 and Mahajan and Billore, 2014). The infiltration of alkaline pH water or saline water from adjacent prawn ponds has led to an increase in the pH and EC of nearby paddy fields, as compared to fields located farther away. High accumulation of salts could be attributed to movement of saline water (Awad *et al*., 2014). Organic carbon content in the soil increased with increasing distance from the aquaculture pond, ranging from 0.35% at 5 meters to 0.42% at 70 meters. This represents an approximate 17% increase in organic carbon content between the two distances. The influence of alkalinity declined with increase in distance from the pond. At higher EC levels, the CO_2 evolution was decreased (Pathak and Rao, 1998) which indicated the suppression of microbial activity and decrease in organic matter decomposition rate. Reducing salinity and sodicity enhances the availability of soil organic matter for utilization by the soil microbial community (Muhammad *et al*., 2008). Therefore, an increase in soil electrical conductivity was associated with a reduction in organic carbon content. Available soil nitrogen, phosphorus, and potassium also exhibited an increasing trend with distance from the aquaculture pond, ranging from 135 to 165 kg ha^{-1} for nitrogen, for phosphorus the range was noticed in between 18.6 to 34.8 kg ha^{-1}, while potassium levels varied from 309 to 435 kg ha^{-1}. This trend suggests a reduction in the influence of salinity on nutrient availability with increasing distance from the pond. The findings of our study are consistent with those reported by Pathak and Rao (1998). They stated that the nitrogen mineralization decreased with increase in pH. This might be due to the volatilization losses of nitrogen at high pH (Laura, 1974). P losses increased in alkali soils, whereas P losses were low in non-alkali soils (Misra *et al*., 2007). In soils with high pH and EC, the chemical environment is unfavorable for the availability and uptake of N, P and K due to chemical transformations, nutrient fixation or competition and soil structure and biological activity limitations. Soil concentrations of sodium, sulfur, and total dissolved solids (TDS) decreased with increasing distance from the prawn ponds, ranging from 127 to 180 ppm for sodium, 7 to 14 ppm for sulfur, and 0.98 to 1.6 ppm for TDS. At 5 meters from the pond, the levels of sodium, sulfur, and TDS were approximately 29%, 50%, and 39% higher, respectively, compared to those at 70 meters. This decline in concentration with distance may be attributed to the lateral movement and inundation of water containing elevated levels of sodium and dissolved solids from prawn ponds into adjacent fields, particularly in the absence of trench barriers.

Acquaponds without trench in soils with fish cultivation

The soil samples were collected from the paddy fields of Kodamanchili ,Navuduru, Gondi, Chinamamidipalli and Mallavaram villages growing fish in their acqua ponds without trench (Table 3) were identified and collected soil samples at a distance of 0,5,10,20,30,40,50,60,70 m from the pond to the paddy field and up to a depth of 30 cm were collected and analysed. The results in soils with fish cultivation without trench revealed that the pH, electrical conductivity and sodium % decreased with distance upto 50 m and % Organic carbon (0.30-0.36%) and the available nutrients Nitrogen (235-260 kg ha^{-1}) P_2O_5 (36.5-35.8 kg ha^{-1}) K_2O (365-375 kg ha^{-1}) increased with the distance upto 50 m. In contrast to shrimp farming, only slight changes were observed in the physico-chemical characteristics of the soil. In case of sandy soils due to more seepage and percolation problem the chemical properties vary with clay soil acquaponds both in shrimp and fish cultivation. In shrimp cultivation, high feeding rates and fertilization contributes to accumulation of carbonates, bicarbonates and ammonia which leads to higher alkalinity and pH.Ammonia levels in shrimp farms were found to be higher during both wet and dry seasons compared to other systems, possibly due to the decomposition of aquatic weeds, accumulated organic matter, and uneaten feed (Zafer *et al*., 2015).

Acquaponds with trench in soils with shrimp cultivation

The soil samples were collected from the fields of farmers cultivating shrimp with trench from Kuppanapudi, Penumanchili, Ganapavaram, Penumantra and Attili villages and the samples were analysed for the pH, electrical conductivity, available nutrient contents and sodium content. The average values of the soil properties are presented in Table 2. Soil physico-chemical properties were observed to vary within the following ranges: pH from 6.0 to 7.0, electrical conductivity (EC) from 0.5 to 2.1 dSm^{-1}, organic carbon (OC) from 0.5% to 0.6%, available nitrogen from 190 to 215 kg ha^{-1}, available phosphorus from 34.8 to 35.2 kg ha^{-1}, available potassium from 341 to 390 kg ha^{-1}, sodium from 120 to 135 ppm, sulfur from 8 to 9 ppm, and total dissolved solids (TDS) from 0.82 to 1.4 ppm.The presence of a trench allows saline or wastewater from the aquaculture ponds to flow into the drainage system, eventually discharging into the main drainage channel. There is no scope for the saline water to enter into the paddy field however due to some salinity water entered by seepage there was a slight change in properties in soils nearby the acquapond. Hence, there was not much change in soil properties.

Acquaponds with trench in soils with fish cultivation

The soil samples were collected from the paddy fields of farmers in Likhitapudi, Vempa, Mogalthuru, Matsyapuri and Mamidigunta villages upto a distance of 70 m from the acquapond cultivation fish in their ponds with trench. The results revealed that there was not much deviation in pH, electrical conductivity and available nutrient content (Table 4). The soil physico-chemical parameters were found within the following ranges: pH ranged from 6.6 to 7.0, electrical conductivity (EC) from 0.4 to 0.89 dSm^{-1}, organic carbon (OC) from 0.75% to 0.78%, available nitrogen from 225 to 255 kg ha^{-1}, available phosphorus from 36 to 36.7 kg ha^{-1}, and available potassium from 352 to 420 kg ha^{-1}. Sodium concentrations varied between 120 and 135 ppm, sulfur between 10 and 12 ppm, and total dissolved solids (TDS) ranged from 0.82 to 1.4 ppm. In sandy soils the change in soil properties varying with increase in distance from the pond as the seepage losses and percolation losses are more in sandy soils (Table 5).

The distance between acqua pond and paddy field in case of clay soils a gap of more than 50 m – 70 m between the acqua pond and paddy field is necessary. The acquaculture and paddy field cultivation can coexist successfully in coastal areas if there are buffer zones in between. The paddy cultivation without any problems will grow besides the acquaponds if there was a possibility to establish a buffer zone of 10 m width and 4m depth with fresh water then acquapond will not impair paddy cultivation. The buffer zone proved effective in preventing the salinization of nearby agricultural land. Andhra Pradesh state stands to gain profits through shrimp farming and it will be a loss if we fail to promote it in a sustainable way.Integrating aquaculture with rice cultivation enables farmers to produce both crops on the same plot of land. Incorporation of green manures, FYM and compost can improve the physical properties of soil and reduces the impact of aqua ponds soil properties.

Table 1. Changes in soil properties with prawn cultivation without trench

Distance from pond	pH	EC	Organic carbon	Available nutrients			Na	TDS	S
				Nitrogen	Phosphorus	Potasium			
(m)		(dSm^{-1})	(%)		($kg\ ha^{-1}$)		ppm	ppm	ppm
5 m	8.0	4.2	0.35	135	18.6	309	180	1.60	14
10 m	8.0	4.1	0.35	138	25.2	321	167	1.80	10
20 m	7.5	4.0	0.36	145	27.5	365	155	1.75	9
30 m	7.0	3.9	0.35	148	28.9	402	145	1.62	8
40 m	6.5	3.8	0.38	156	30.6	415	142	1.42	8
50 m	6.2	3.8	0.40	158	31.5	421	135	1.10	7
60 m	6.0	3.6	0.42	163	32.6	432	133	1.08	7
70 m	6.0	3.2	0.42	165	34.8	435	127	0.98	7

Table 2. Changes in soil properties with prawn cultivation with trench

Distance from pond	pH	EC	Organic carbon	Available nutrients			Na	TDS	S
				Nitrogen	Phosphorus	Potasium			
(m)		(dSm^{-1})	(%)		($kg\ ha^{-1}$)		ppm	ppm	ppm
5 m	7.0	2.1	0.5	215	35.2	341	135	1.40	9
10 m	7.0	2.0	0.52	210	33.5	341	137	1.50	8
20 m	6.5	1.8	0.55	212	33.0	325	127	1.35	8
30 m	6.2	1.2	0.55	200	32.5	352	125	1.32	8
40 m	6.0	1.0	0.56	198	32.0	385	122	1.22	8
50 m	6.1	0.5	0.60	190	32.5	392	120	1.00	8
60 m	6.0	0.5	0.60	190	32.6	390	120	0.92	8
70 m	6.0	0.5	0.60	190	34.8	390	120	0.82	8

Table 3. Changes in soil properties with fish cultivation without trench

Distance from pond	pH	EC	Organic carbon	Available nutrients			Na	TDS	S
				Nitrogen	Phosphorus	Potasium			
(m)		(dSm^{-1})	(%)		($kg\ ha^{-1}$)		ppm	ppm	ppm
5 m	7.5	1.5	0.3	235	36.2	365	135	1.40	9
10 m	7.2	1.3	0.30	232	36.0	358	137	1.50	8
20 m	7.2	1.2	0.29	238	34.0	358	127	1.35	8
30 m	7.0	1.2	0.32	245	33.8	362	125	1.32	8
40 m	7.0	1.0	0.35	252	34.8	365	122	1.22	8
50 m	7.0	0.8	0.36	255	35.8	370	120	1.00	8
60 m	7.0	0.7	0.36	260	35.8	372	120	0.92	8
70 m	7.0	0.7	0.360	260	35.8	375	120	0.82	8

Table 4. Changes in soil properties with fish cultivation with trench

Distance from pond (m)	pH	EC (dSm^{-1})	Organic carbon (%)	Available nutrients (kg ha^{-1}) Nitrogen	Phosphorus	Potasium	Na (ppm)	TDS (ppm)	S (ppm)
5 m	7.0	0.89	0.78	225	36.7	352	135	1.40	12
10 m	7.0	0.56	0.77	224	36.0	355	137	1.50	12
20 m	7.0	0.52	0.77	224	36.2	336	127	1.35	12
30 m	7.0	0.45	0.75	235	36.4	362	125	1.32	10
40 m	6.8	0.42	0.76	237	36.0	385	122	1.22	10
50 m	6.8	0.40	0.76	245	35.6	392	120	1.00	10
60 m	6.8	0.42	0.76	252	36.6	425	120	0.92	10
70 m	6.6	0.40	0.75	255	36.0	420	120	0.82	10

Table 5. Changes in soil properties with distance in sandy soil without trench and with trench

Without trench				With trench			
Distance from pond (m)	pH	EC (dSm^{-1})	TDS (ppm)	pH	EC (dSm^{-1})	TDS (ppm)	Na (ppm)
5	7.4	1.45	4.50	5.0	1.25	3.3	184
10	6.5	1.32	6.80	4.8	1.12	4.2	192
20	6.5	1.25	4.30	4.7	1.0	4.2	221
30	6.5	1.20	4.90	4.9	1.0	4.2	158
40	6.6	1.20	3.40	5.0	0.98	3.8	142
50	6.4	1.18	3.30	5.0	0.89	3.8	156
60	6.6	1.18	3.20	5.0	0.82	3.0	136
70	6.4	1.18	2.90	5.0	0.84	3.0	136

REFERENCES

Awad, M. Y., M. S. Abowaly and A. S. El-Shahaway, 2014.Effects of Fish Farming Land use on Some Soil Chemical Properties and Availability of Some Micronutrients. Assiut J. Agric. Sci **45** (1): 100-115.

Bardsley, C. E. and J. D. Lancaster, 1960.Determination of reserve sulfur and soluble sulfates in soils. Soil Sci. Soc. Am. J. **24** (4): 265-268.

Bodhe, Y. G., V. S. Wadhai, J. W. Hajare, D. G. Atla and N. Sigh, 2022. Important of *Bacillus thuriengensis* in bacterial diseases of fish and their control in aquaculture. J. Soils and Crops, **32** (2): 398-403.

Butle, S. S., R. A. Gulhane, and P. S. Joshi, 2022. Study on effects of dietary wheat grass on behavioural responses of fresh water fish Channa striata. J. Soils and Crops, **32** (2):393-397.

Flaherty, M., P. Vandergeest and P. Miller, 1999. Rice paddy or shrimp pond: tough decisions in rural Thailand. World Dev. **27** (12): 2045-2060.

Gupta, B.P., K.K. Krishnan, K.O. Joseph, M. Muralidhar, A. Nagarvel and V. Parimala, 2002.Studies on the effect of shrimp farming on adjacent agricultural land and underground water in Cuddalore district of Tamilnadu. J. Appl. Fish. Aquac.**11** (1): 47-50.

Jackson, M. L. 1973. Soil chemical analysis-advanced course: A manual of methods useful for instruction and research in soil chemistry, physical chemistry of soils, soil fertility, and soil genesis.

Jayanthi, L. D., D. J. Samuvel and S. Ramamoorthy, 2004. Regulated internalization and phosphorylation of the native norepinephrine transporter in response to phorbol esters: evidence for localization in lipid rafts and lipid raft-mediated internalization. J. Biol. Chem. **279** (18): 19315-19326.

Laura, R. D. 1974. Effects of neutral salts on carbon and nitrogen mineralization of organic matter in soil. Pl. Soil **41**: 113 - 127.

Mahajan, S. and D. Billore, 2014.International Science Congress Association 26 assessment of physico-chemical characteristics of the soil of Nagchoon Pond Khandwa, MP, India. Res. J. Chem. **4** (1): 26-30.

Misra, S. M., K. N. Tiwari and S. S. Prasad, 2007. Reclamation of alkali soils: influence of amendments and leaching on transformation and availability of phosphorus. Commun. Soil Sci. Plant Anal. **38**(7-8): 1007-1028.

Muhammad, S., T. Muller and R. G. Joergensen, 2008.Relationships between soil biological and other soil properties in saline and alkaline arable soils from the Pakistani Punjab. J. Arid Environ. **72** (4): 448-457.

Muhr, G.R., N.P. Datta, N.S. Subramany, F. Dever, V.K. Lecy and R.R. Donahue, 1965.Soil testing in India, USDA Publication.pp 120.

Olsen, S. R. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate.US Department of Agriculture. 939.

Pathak, H. and D. L. N. Rao, 1998.Carbon and nitrogen mineralization from added organic matter in saline and alkali soils. Soil Biol. Biochem **30** (6): 695-702.

Penmetsa, A. R. K. R., S. R. Muppidi, R. Popuri, S. B. Golla and R. Tenneti, 2013. Impact of aquaculture on physico-chemical characteristics of water and soils in the coastal tracts of East and West Godavari Districts, Andhra Pradesh, India. Int. J. Eng. Trends Technol. **6**: 313-319.

Rahman, M. M., V. R. Giedraitis, L. S. Lieberman, T. Akhtar and V. Taminskiene, 2013. Shrimp cultivation with water salinity in Bangladesh: The implications of an ecological model. Univers. J. Public Health,**1** (3): 131-142.

Rajarshi, M. and S. C. Santra, 2011. Influence of Brackish water aquaculture on soil salinisation. Int. J. Res. Chem. Environ. **1**: 60-65.

Siddique, M. A. M., P. Barua and M. H. Ghani, 2012.Comparative study of physico-chemical properties of soil according to the age of aquaculture pond of Bangladesh. MJMS, **27** (1): 29-38.

Subbaiah, B. V. and G. L. Asija, 1956.A rapid procedure for the estimation of available nitrogen in soil.Curr. Sci. **25**: 258 - 260.

Teng, S. K. 2008. Risk analysis of the soil salinisation due to low-salinity shrimp farming in central plain of Thailand. GESAMP, **76**: 162-175.

Zafar, M. A., M. M. Haque, M. S. B. Aziz and M. M. Alam, 2015. Study on water and soil quality parameters of shrimp and prawn farming in the southwest region of Bangladesh. JBAU, **13** (1): 153-160.

Rec. on 04.06.2025 & Acc. on 12.06.2025